



# Environment and Natural Resources Trust Fund

2021 Request for Proposal

## General Information

**Proposal ID:** 2021-279

**Proposal Title:** Optimizing Youth Sports Fields to Reduce Environmental Impact

## Project Manager Information

**Name:** Eric Watkins

**Organization:** U of MN - College of Food, Agricultural and Natural Resource Sciences

**Office Telephone:** (612) 624-7496

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## Project Basic Information

**Project Summary:** Sports fields are an important, neglected landscape that children throughout Minnesota interact with almost daily. We will optimize maintenance of these landscapes to improve function and environmental impacts.

**Funds Requested:** \$957,000

**Proposed Project Completion:** 2024-06-30

**LCCMR Funding Category:** Water Resources (B)

## Project Location

**What is the best scale for describing where your work will take place?**

Region(s): Metro

**What is the best scale to describe the area impacted by your work?**

Statewide

**When will the work impact occur?**

During the Project and In the Future

## Narrative

### **Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.**

Amateur youth sports in Minnesota are an important part of daily life. Parents shuttle their kids from place to place, devoting significant time and resources to activities that help build healthy habits. The growth in youth sports has required significant investments by schools, cities, counties, and the state of Minnesota in the building and maintenance of sports fields. These fields are assumed to be safe environments for youth athletics. However, the decision makers (school boards, city councils, county boards) who are charged with making sure these fields are available for use often have little recurring budget allowances for field maintenance and replacement. As a result, natural grass fields fall into disrepair, creating unsafe playing conditions. These conditions could have been remedied with proper turfgrass management practices, but budgetary challenges overwhelm this need. Research efforts have, for the most part, not considered how proper management of youth sports fields can reduce environmental impacts and improve athlete outcomes, including reducing injuries. In this proposal, we outline an approach using the National Sports Center (NSC) in Blaine as a living laboratory where we will test best management practices to improve natural turfgrass sports fields that can improve both environmental impacts and athlete safety.

### **What is your proposed solution to the problem or opportunity discussed above? i.e. What are you seeking funding to do? You will be asked to expand on this in Activities and Milestones.**

Reducing environmental impact of sports fields will require the implementation of best management practices that are economically viable and easily implemented. In Activity 1, we will compare the environmental impact and effectiveness of multiple cultivation treatments to reduce sports field compaction. Specifically, our goal is to 1) predict compaction given field management, use, and other factors, and then 2) predict the water quality impacts of compaction. Next in Activity 2, we will monitor youth athlete performance and see how sports field characteristics affected athlete outcomes. Finally, we will survey decision makers throughout the state of Minnesota so as to better inform outreach efforts. Currently, there is little data that can be used to inform these important, and often costly decisions. Understanding how these stakeholders think about sports fields will allow use to design more effective outreach. This project is unique in that it considers the environmental impacts of sports field management decisions while also giving attention to youth athlete performance and safety. We will reach these stakeholders through in-person and online presentations (school board meetings, etc.) and through articles in appropriate newsletters and trade magazines. We will reach scientific audiences through presentations at conferences and peer-reviewed scientific journal articles.

### **What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?**

Each decision to build a new, artificial sports field costs Minnesotans upwards of \$750,000. At a time of financial stress, this money might better be directed toward the proper maintenance of existing playing surfaces with savings going towards other important societal needs. We will provide decision makers at school districts and other decision-making bodies throughout Minnesota the information they need to make decisions about field maintenance and replacement.

## Activities and Milestones

### Activity 1: Determine best management practices for sports fields that optimize function while reducing environmental impact

**Activity Budget:** \$511,416

#### Activity Description:

We will deploy experiments across 12 fields at the NSC and the adjacent water holding ponds. First, fields will be selected based on an assessment using the Toro Precision Sense 6000, a mobile sampling device that simultaneously measures volumetric water content (VWC), penetration resistance, and normalized difference vegetation index (NDVI; a measurement of plant health) on all fields. We will include four treatments (individual fields will be experimental units): (1) standard current practices at NSC on natural grass field; (2) standard current practices on artificial turf field; (3) cultivation practice 1; (4) cultivation practice 2. Treatments 3 and 4 will be determined in consultation with sports turf managers. We will collect real-time streams of soil compaction predictors, such as soil temperature, soil moisture, and other agroenvironmental parameters. These data will be integrated with aerial imagery of the fields over time and gridded sampling of compaction over time using the hammer drop method. Furthermore, we will instrument the constructed weirs with depth and nitrate sensors to understand how different levels of compaction and its spatial variation affects water quality. All tested fields will be assessed using the PS6000 regularly through the study period.

#### Activity Milestones:

Description	Completion Date
Map sports fields at NSC using Precision Sense machine and identify fields for study	2021-10-31
Install sensors and other data collection systems on soccer fields at NSC	2022-06-30
Assess performance of fields during soccer tournaments	2023-10-31
Complete data collection and analyze results	2024-03-31

### Activity 2: Assess sports field user preferences and outcomes in response to alternative management practices

**Activity Budget:** \$314,751

#### Activity Description:

Athletes playing on NSC fields will be tracked during play with Global Positioning System (GPS) microtechnology sensors integrated with simultaneous game video. The fields at NSC reflect varied surface conditions, field properties and management practices. GPS sensors, software, and video produce a variety of metrics indicating quality and quantity of sports performance (e.g., speed, sprints) and injuries (e.g., video and GPS signature associated with injury events). Customizable map overlays using GIS spatial analytic methods will integrate performance, injuries, and field conditions (e.g., soil compaction) and identify areas of risk. Self-report data from athletes, coaches, and parents will be assessed via the use of a specially tailored app that gathers information about a variety of parameters related to field conditions (e.g., perceptions of injury risks and field quality), injuries (e.g., type, location, severity), athlete wellness (e.g., sleep, soreness, fatigue, exertion), and game strategies (e.g., footwear and coaching based on field conditions). Performance, injuries, and perceptions will be compared across natural versus artificial turfgrass, and between fields utilizing alternative management practices to better assess the risk and protective factors associated with athlete-surface interactions. These results will be summarized to help inform decision makers.

#### Activity Milestones:

Description	Completion Date
Test new mobile application for social science surveys	2021-09-30
Derive and map metrics of sports performance outcomes from GPS data	2023-09-30
Collect GPS and video data of sports teams playing on four treatment field conditions	2023-09-30
Connect sports performance data with field performance data from Activity 1 for final analysis	2024-06-30

### Activity 3: Survey decision makers about sports fields to inform outreach and education

**Activity Budget:** \$130,833

**Activity Description:**

We will conduct a statewide survey with decision makers to understand their current sport field management practices, and barriers to adopting natural sport fields. We will ask questions about familiarity, knowledge of, and attitudes toward natural and artificial sports fields, if they are willing to adopt natural sport fields, the major concerns that prevent them from adopting natural sport fields and the benefits that motivate them to adopt, and the media where they get information. We will also ask their demographics and questions about their current facilities. The survey will be mainly an online survey, supplemented by mail-in and telephone surveys. Econometric and statistical models will be employed to determine sport decision makers’ preferences for natural sport fields and to make recommendations on how to inform them on the risks and benefits of natural sports fields. We will explore the key factors driving decision makers’ decisions and identify strategies to overcome barriers. Results from these surveys will then be used to develop outreach presentations and online resources to better inform decision makers. Finally, during June 2022 and 2023, our seven team members will lead a half-day STEM educational session as part of a summer camp at the NSC.

**Activity Milestones:**

Description	Completion Date
Design survey questions and compile survey participant contact information (email, phone number or mailing address)	2022-07-31
Distribute survey to survey participants	2023-07-31
Data cleaning and analysis, report and manuscript written up	2024-06-30

## Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Toben Nelson	University of Minnesota	Toben Nelson, associate professor in Public Health, is a social epidemiologist with specific training and expertise in policy, injury prevention, environmental prevention strategies, intervention development, evaluation, longitudinal analysis, and multilevel statistical modeling. He will be involved in the development and deployment of a survey application in Activity 2.	Yes
Diane Wiese-Bjornstal	University of Minnesota	Diane Wiese-Bjornstal is the Associate Director of the School of Kinesiology and a professor in Sport and Exercise Psychology. She has expertise in youth sport science, and will be involved in athlete tracking work described in Activity 2.	Yes
Ying Song	University of Minnesota	Ying Song, assistant professor in Geography, Environment, and Society, has primary research interests in geospatial science, spatial-temporal analytics, and sustainable mobility. Her recent research applies methods and techniques in GIScience, geocomputation and data mining to study individuals' movement; she will apply these methods to athlete movement in Activity 2.	Yes
Bryan Runck	University of Minnesota	Bryan Runck, Geocomputing Scientist with the GEMS Agroinformatics Initiative, is trained broadly in the field of geocomputing, artificial intelligence, and machine learning, with specific emphasis on applications in agriculture. He understands both the computational and agricultural aspects of this project and will lead remote sensing work in Activity 1.	Yes
Chengyan Yue	University of Minnesota	Yue holds the Todd and Barbara Bachman Endowed Chair in Horticultural Marketing, Professor at the Department of Horticultural Science and Department of Applied Economics at the University of Minnesota. She will lead the decision maker survey in Activity 3.	Yes
John Chapman	University of Minnesota	John Chapman, assistant research professor in Bioproducts and Biosystems Engineering, has interests that generally revolve around soil and water behavior and interaction. He will be involved in water quality components of the research outlined in Activity 1, including advising a graduate student on the project.	Yes

## Long-Term Implementation and Funding

**Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this be funded?**

The funding we are requesting will help lay the foundation for future funded projects. Federal granting agencies will be interested in the public health and precision landscape management. State agencies will be interested in applied projects that provide information to school boards and other local non-profit bodies in Minnesota on how to spend precious financial resources. Professional sports leagues and private foundations will be excited about the ways this work can impact local communities. Commercial partners, like The Toro Company (see attached letter), will see myriad opportunities for research and development in landscape management and youth sports safety.

## Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Bee Pollinator Habitat Enhancement - Phase II	M.L. 2016, Chp. 186, Sec. 2, Subd. 08a	\$387,000

## Project Manager and Organization Qualifications

**Project Manager Name:** Eric Watkins

**Job Title:** Professor

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**Provide description of the project manager’s qualifications to manage the proposed project.**

Professor Watkins leads the turfgrass science program at the University of Minnesota, where he has been on the faculty of Horticultural Science since 2004. Watkins received his undergraduate degree from the University of Minnesota in 1998 and his Ph.D. from Rutgers University in Plant Biology in 2004. His program conducts research related to turfgrass breeding, selection, and management, along with collaborations in social science, to increase the use of sustainable turfgrass species in multiple landscape types. He has led a number of large, multi-institutional projects on the improvement of low-input fine fescues. He has also worked with the Minnesota Department of Transportation on turfgrass selection and management for roadsides to reduce environmental impact and leads a project with the Met Council on reducing water use on lawns in the Twin Cities. He contributed significantly to recent LCCMR-funded projects focused on the development of "bee lawns". Dr. Watkins is active in outreach, giving presentations to multiple audiences ranging from homeowners to golf course superintendents. At the University, he teaches a number of courses on the topics of turfgrass management and plant breeding.

**Organization:** U of MN - College of Food, Agriculture and Natural Resource Sciences

**Organization Description:**

The College of Food, Agricultural, and Natural Resources Sciences, at the University of Minnesota, aims to inspire minds, nourish people, and enhance the natural environment. The college’s vision is to advance Minnesota as a global leader in food, agriculture, and natural resources through extraordinary education, science-based solutions, and dynamic public engagement that nourishes people and enhances the environment in which we live. The college has 13 academic departments, including Horticultural Science, home of the turfgrass science program. The turfgrass science program has the field, laboratory, growth chamber, and greenhouse facilities needed for innovative research to serve the needs of Minnesota stakeholders.

## Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
<b>Personnel</b>								
Faculty - John Chapman		Will lead activity of determining water runoff and water quality impacts			36.5%	0.21		\$32,199
Faculty - Diane Wiese-Bjornstal		Will lead tracking athletes on the fields to gauge performance			36.5%	0.15		\$27,978
Graduate Student in Geography - TBD		Data analysis and visualization			81.16%	1		\$94,576
Graduate Student in BBE - TBD		Determine water runoff and water quality impacts			83.18%	1		\$97,973
Graduate student in APEC - TBD		Economic analysis			88.02%	1		\$93,410
Graduate student in Kinesiology - TBD		Analyze athlete performance on fields			88.16%	0.5		\$46,647
Researcher 3 - TBD		Assist GEMS team in field sensor deployment and data collection			31.8%	1		\$79,871
Laboratory Technician - Derrick Ferguson		Construct wiers for field for water quality research			31.8%	0.06		\$4,848
Faculty - Eric Watkins		Will coordinate the grant and oversee all project activities			36.5%	0.12		\$22,817
Faculty - Ying Song		Will lead work on data analysis and visualization			36.5%	0.24		\$36,599
Geocomputing Scientist - Bryan Runck		Will lead designing and deploying sensing systems on fields			36.5%	0.51		\$58,108
Undergraduate workers		Assist in field research for Activities 1 and 2			0%	1.83		\$45,000

Researcher 5 - Kristine Moncada		Coordinate education and outreach efforts			31.8%	0.6		\$49,633
Researcher 3 - TBD		Assist in turfgrass field research			31.8%	1.5		\$100,840
							<b>Sub Total</b>	<b>\$790,499</b>
<b>Contracts and Services</b>								
SoundRocket	Professional or Technical Service Contract	Company to develop the survey app development for monitoring athlete health				0.25		\$50,000
							<b>Sub Total</b>	<b>\$50,000</b>
<b>Equipment, Tools, and Supplies</b>								
	Tools and Supplies	Construction materials for flow wiers	flow wiers are part of the system we will use to determine the impact on water runoff and water quality					\$1,600
	Tools and Supplies	jersey base layers for youth - 20	Extra base layers for youth athletes are needed to fit the GPS trackers within the player uniforms					\$900
	Tools and Supplies	Field supplies for turfgrass research (seed, stakes, fertilizer, sampling materials)	gauge impact of alternative turfgrass management practices					\$3,000
	Tools and Supplies	Supplies to construct nitrogen calibration equipment for 16 field sensors	Sensors will detect nitrogen to help gauge environmental impact of fertilizer application					\$20,000
	Equipment	sensor node hardware - 16	sensor nodes to be adapted to collect data on fields					\$16,000
	Equipment	25 GPS trackers for athletes, 2 charge strip hubs for trackers	Athletes will wear GPS trackers during games to determine performance and injury relating to field conditions					\$6,150
	Equipment	Video camera, battery and charger	Video will be taken of athlete during games to gauge performance and injury occurrence					\$2,689
	Equipment	ultrasonic level indicators - 16	to determine water volume in weirs					\$1,600
	Equipment	data loggers - 16	to collect data in flow wiers to determine environmental impacts					\$3,200

							<b>Sub Total</b>	<b>\$55,139</b>
<b>Capital Expenditures</b>								
							<b>Sub Total</b>	<b>-</b>
<b>Acquisitions and Stewardship</b>								
							<b>Sub Total</b>	<b>-</b>
<b>Travel In Minnesota</b>								
	Miles/ Meals/ Lodging	mileage to travel to field site, approx 3450 miles/yr	Researchers travel to field site in Blaine is where research will be conducted					\$6,000
							<b>Sub Total</b>	<b>\$6,000</b>
<b>Travel Outside Minnesota</b>								
							<b>Sub Total</b>	<b>-</b>
<b>Printing and Publication</b>								
	Publication	Fees for two journal articles	Publish research results for economic analysis					\$4,000
							<b>Sub Total</b>	<b>\$4,000</b>
<b>Other Expenses</b>								
		2 year software subscription Raw Data Plug-In (JSON)	software for use in kinesiology data analysis					\$500
		software subscription for 3 years	field sensor software					\$38,295
		UAV software subscription for 3 years	Drone used to collect field attributes					\$12,000
		Camera repair and maintenance, plus shipping to repair shop	video camera for recording athlete games will need repair and maintenance					\$567
							<b>Sub Total</b>	<b>\$51,362</b>
							<b>Grand Total</b>	<b>\$957,000</b>

5/17/2020

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Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
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Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
<b>State</b>				
			<b>State Sub Total</b>	-
<b>Non-State</b>				
			<b>Non State Sub Total</b>	-
			<b>Funds Total</b>	-

## Attachments

### Required Attachments

#### *Visual Component*

File: [80ad6a2e-874.pdf](#)

#### *Alternate Text for Visual Component*

School and public sports fields are a significant investment for our state, yet they are consistently neglected, leading to unsafe conditions for athletes and adverse environmental impacts. This graphic shows that our project will examine both field attributes (compaction) and athlete outcomes (in this example, speed). Soil compaction is a sports field characteristic that affects athlete performance, injury occurrence and the environment. As shown on the first map, there can be varying degrees of compaction; this inconsistency can lead to injury. Compaction also leads to poor water infiltration that can cause to storm water runoff and erosion. The next pair of maps show the distribution of GPS points and speeds within a sports field based on tracking athletes during game play. We will use customizable map overlays using GIS spatial analytic methods and will integrate performance, injuries, and field conditions (e.g., soil compaction) and identify areas of risk. Ultimately, improving natural turfgrass sports fields will help in the safety of our young athletes while increasing protection of our environment.

### Optional Attachments

#### *Support Letter or Other*

Title	File
Letter of Collaboration National Sports Center	<a href="#">66a70317-6a5.pdf</a>
Letter of Support Toro	<a href="#">72058a05-b72.pdf</a>

## Administrative Use

**Does your project include restoration or acquisition of land rights?**

No

**Does your project have patent, royalties, or revenue potential?**

No

**Does your project include research?**

Yes

**Does the organization have a fiscal agent for this project?**

Yes, Sponsored Projects Administration

# Optimizing Youth Sports Fields to Reduce Environmental Impact

Eric Watkins, Bryan Runck, Chengyan Yue, Diane Wiese-Bjornstal, John Chapman, Toben Nelson, and Ying Song; University of Minnesota

School and public sports fields are a significant investment for our state, yet they are consistently neglected, leading to unsafe conditions for athletes and adverse environmental impacts.

*Our project will optimize maintenance of these landscapes to improve function for athletes and reduce negative environmental impacts; our three activities will be to:*

1. Determine best management practices for sports fields that optimize function while reducing negative environmental impacts
2. Assess sports field user preferences and outcomes in response to alternative management practices
3. Survey decision makers about sports fields to inform outreach and education



## SPORTS FIELD ATTRIBUTES

Soil compaction is an example of a sports field characteristic that affects athlete performance, injury occurrence AND the environment. As shown on this map, there can be varying degrees of compaction; this inconsistency can lead to injury. Compaction also leads to poor water infiltration that can cause to storm water runoff and erosion.

## ATHLETE OUTCOMES

These maps show the distribution of GPS points and speeds within a sports field based on tracking athletes during game play. We will use customizable map overlays (as shown to the right) using GIS spatial analytic methods and will integrate performance, injuries, and field conditions (e.g., soil compaction) and identify areas of risk.



Improving natural turfgrass sports fields will help in the safety of our young athletes while increasing protection of our environment.

